CHAPTER-VI

INSTITUTE OF WOOD SCIENCE AND TECHNOLOGY BANGALORE

The Institute of Wood Science and Technology (IWST), Bangalore, formed in 1988 is mandated to conduct research on wood science and technology as its National level objective and focuses its research to important forestry research needs of the States of Karnataka, Andhra Pradesh and Goa at regional level. There are six divisions in the Institute viz., Wood Properties and Uses, Wood Seasoning and Preservation, Chemistry of Forest Products, Wood Biodegradation, Tree Improvement and Propagation of Wood Energy and also advance studies center in areas of improved utilizations of wood, mangroves and coastal ecology and research on sandal.

PROJECTS COMPLETED DURING 1999-2000

Sl. No.: IWST OC-4

Project identification No.: WSP1

Name of the principle investigator : Pankaj K. Aggarwal

Title of the project : Effect of growth stresses in processing of timber from plantations.

Year of start of the project : 1997

Cost of the project : Rs. 9.5 lakhs

Objectives: To study magnitude and variation of growth stresses in trees and logs to adopt an appropriate technique of conversion for reducing wastage.

Scientific importance of investigations: This study will help in conserving the wood resource and optimizing the utility of timber. The study will use non-destructive process.

Results/Achievements : Developed a microprocessor based strain gauge meter to measure growth strain in trees and logs non-destructively.

Preliminary study on growth strains in five clones of *Eucalyptus tereticornis* (obtained from Bhadrachalam) indicated variation in strain with respect to clones.

Study on the effect of lignin content on *Eucalyptus tereticornis* indicated that presence of high lignin content does not contribute to the high growth strain.

LGS measured in *Acacia auriculaeformis* was found to be high in the middle portion as compared to bottom and top portion. The pattern of strain variation was significantly different compared to other species tested so far. The strain was observed to vary with the age and as the age increases strain was found to decrease.

Study made on the effect of longitudinal growth strain on physical properties of wood showed that a high degree of correlation exist between longitudinal growth strain and volumetric shrinkage. Where as no such correlation was observed in respect of MOE or density.

Sl. No.: IWST OC- 6

Project identification No.: WSP 3

Name of the principle investigator : K.K. Pandey

Title of the project : Weathering of wood surface and its protection.

Year of start of the project: 1997

Cost of the project: Rs.50.00 lakhs

Objectives: (a) To study the interaction of wood and its constituents with weathering factors. (b) Evaluation of the efficacy of chemical pre-treatments in surface protection of wood under outdoor exposure. (c) Enhancing the life of paint coatings on wood surface.

Scientific importance of investigations : Understanding the interaction of weathering factors with wood and its constituents to provide an insight into the weathering processes for both finished or unfinished wood substrates and for further development of new pretreatment and finishes for enhancing durability.

Results/Achievements : Deterioration of wood surface of *Hevea brasiliensis* exposed for outdoor weathering was analysed by scanning electron microscopy (SEM). Rapid surface deterioration (roughening of surface) and preferential degradation of middle lamella was observed in samples exposed for two weeks. Also checking and roughening of cell wall and damage of pit structure in samples exposed for longer duration was observed. Further work on untreated and wood treated with chromium, ferric salts etc. and acetylated rubber wood was in progress.

Performance of three types of commercial paints namely synthetic enamel paint, acrylic paint and poly urethane paint was evaluated on wood of *Hevea brasiliensis* and *Pterocarpus marsupium* species after pre-treatment with five inorganic salt solutions for different periods under outdoor exposure. Study showed that performance of wood by synthetic enamel paint was best among the paint varieties, during a study period of 38 months of outdoor exposure.

Sl. No.: IWST OC – 7

Project identification No.: WSP4

Name of the principle investigator : S.S. Chauhan

Title of the project : Chemical Modification of Wood.

Year of start of the project : 1997

Cost of the project : Rs. 13 lakh

Objectives: (a) To evolve cost-effective technique of chemical modification of wood for specific end use requirements such as dimensional stability, water Repellency and biological resistance. (b) To impart novel properties like themoplasticity and solubility in wood for utilising more efficiently wood wastes, sawdust and secondary timbers.

Scientific importance of investigations : Wood is a three dimensional biopolymer composite made-up of cellulose, hemicellulose and lignin. These polymers are responsible for most of the physical and chemical properties of wood. Most of the degradative phenomenon in wood like dimensional instability, biodegradation, weathering are chemical in nature. Since all the wood constituent polymers possess many

active functional groups, by altering these groups by some other group the chemical nature of the wood can be altered to improve the properties. This research study aims at identifying appropriate modification technique to impart desired properties in wood depending on end use.

Another major scientific importance of the investigation is to impart novel properties like thermoplasticity and liquefaction for developing products like wood based hard/soft foams, resins, resinified wood based moldings, films, sheets.

Also a greater potential application of modification technology lies in reconstituted wood products Veneer products, flake board, particle boards etc. for enhancing the product quality and utilisation of wood waste for value added products.

Results/Achievements : Reaction parameters were optimized for the modification of rubber wood with Maleic anhydride and Phthalic anhydride. Reaction of one part of rubber wood meal with two parts of anhydride at 100°C for 3 to 4 hours in Dimethyl formamide was found appropriate to achieve sufficient loading of chemical. When equal parts of wood and anhydride was used only 5% weight gain was achieved at extreme reaction conditions. The esterified wood was found to have thermoplasticity as well as compatibility with polystyrene.

In study of liquefaction of wood, the ratio of wood to liquefying agent was found to have significant effect on liquefaction. By increasing the ratio from 1: 1 to 1:2 the liquefaction increased by more than 20%. Not much difference in liquefaction rate was observed when dissolved at higher ratios. Liquefaction efficiency of about 80-90 % was achieved when one part of wood and 4 parts of phenol combination was used. Flexible foams of varying density ranging from 0.03 to 0.12 were prepared with 6 parts of wood solution in polyol, 4 parts of methylene diphenylisocyanate and 0.3 parts of water composition at 60°C. These studies would help in tailoring products like foams of desired properties according to end use.

Note : Project not yet complete. It will be submitted to next RAG for extension.

Sl. No.: IWST OC – 8

Project identification No.: WSP 5

Name of the principle investigator : M. Nagraj Sharma

Title of the project : Efficacy of preservatives for enhancing durability of timber.

Year of start of the project : 1997

Cost of the project: Rs. 7 lakh

Objectives: (a) To study the efficacy of preservatives. (b) To generate data on durability of plantation timbers (*Eucalyptus tereticornis*, *Eucalyptus camaldulensis* and *Hevea brasiliensis*).

Scientific importance of investigations: Value addition to the non durable timbers especially from plantations and conservation of other important conventional timber resources.

Results/Achievements: Wooden panels of *Eucalyptus tereticornis, Eucalyptus camaldulensis, Hevea brasilienis* and *Ficus bengalensis* after treatment with three different preservatives (CCA, CCB and ACA) for three different levels of retention of chemicals (4, 8 and 12 kg/m3) have been installed in the test yard for evaluation durability. Results observed for over a period of two years indicated that the minimum loading i.e. 4kg/m^3 is as good as higher loadings given to timber as far as durability is concerned. Further work is in progress.

Similar experiments carried out using three commercially marketed new preservative compositions based on cashew nut shell liquid, by a simple brush coat was found to improve service life in refractory timbers.

Sl. No.: IWST OC 9

Project identification No.: WSP 6

Name of the principle investigator : M. Nagaraj Sharma

Title of the project : Environmental effects of wood preservatives.

Year of start of the project : 1997

Cost of the project: Rs. 7.75 lakh

Objectives: (a) Study of the fixative property of preservative chemicals in treated wood. (b) Control of environmental contamination due to the preservative applications.

Scientific importance of investigations: Control of hazards of wood preserving chemicals in use. Optimisation of loading of chemical for different end uses and evolving suitable recommendations.

Results/Achievements : In a study on leaching behaviour of CCA for treated wood (*Albizia falcataria* for two absorption level viz. 0.5 lb./cft & 1 lb./cft), it was observed that percentage leaching of arsenic was higher compared to either copper or chromium at both levels of absorptions. Similar work on other species used for catamarans, such as *Bombax ceiba* is under progress.

Note: Project not yet complete. It will be submitted for extension in the next RAG.

Sl. No.: IWST OC – 10

Project identification No.: WSP 7

Name of the principle investigator : Ajay Karmarkar

Title of the project : Wood Fibres in Thermoplastic Composites.

Year of start of the project : 1997

Cost of the project: Rs. 14 lakh

Objectives: (a) To improve compatibility between natural fibers and thermoplastics. (b) Improving mechanical and physical properties of thermoplastics. (c) Effective utilisation of lignocellulosic materials and imparting biodegradability to plastics.

Scientific importance of investigations : Lignocellulosics are hygroscopic resources that are basically designed to perform in nature in a wet environment. They are highly polar in nature which makes them chemically incompatible with most non-polar thermoplastics and finally strong hydrogen bonding between the components. In order to incorporate these lignocellulosic fibres in engineering plastics it is necessary to alter the chemistry of its cell wall constituents, at least of the accessible part. The proposed project is an attempt to make compatable natural fiber and plastic alloy with constant, uniform, continuous, predictable and reproducible properties.

Results/Achievements:

(a) Synthesis and Characterization of Maleic Anhydride Grafted Polypropylene (MAPP)

Isotactic polypropylene was grafted in solution with maleic anhydride using benzoyl peroxide as initiator. A factorial design was adopted to study the effect of various parameters such as monomer, initiator

concentration, reaction time, temperature on percentage etc., for grafting. Effect of solvents toluene and xylene was also evaluated. A maximum of 5.2% grafting of maleic anhydride was achieved with toluene as solvent. Whereas, only 2.1% loading could be achieved with xylene. FTIR was used to characterise the grafted product.

(b) Fibre treatment and characterization

Cellulosic fibres (Bleached pulp of Eucalypts) were surface modified with polypropylene-maleic-anhydride copolymer (MAPP) by immersing the fibres in 5% solution of MAPP in hot toluene. It was established that the surface modifying agent is covalently bonded to the wood fibres through esterification. The physical properties of the modified fibre were characterised by measuring the contact angle.

(c) Preparation of composites

The modified fibres were compounded with polypropylene at 20, 30,& 40% fibre loadings. Composites in the form of dumb-bell shape micro specimen using injection molding were made. Modification of hydrophilic fibres with MAPP improved dispersion, wetting, and adhesion of fibres in PP matrix and hence uniform composites could be drawn. Studies on mechanical and physical properties of these composites were in progresses.

Note : Project not yet complete. It will be submitted to next RAG for extension..

Sl. No.: IWST OC – 11

Project identification No.: WSP 8

Name of the principle investigator : A.K. Ananthanarayana

Title of the project : Effect of repeated cycles of wetting and drying.

Year of start of the project : 1998

Cost of the project: Rs. 11 lakh

Objectives: (a) Effects of repeated cycles of wetting and drying of treated timbers on physical properties, surface characteristics and mechanical degradation. (b) Absorption rate and related behaviour of treated wood.

Scientific importance of investigation: Wood being a hygroscopic material, its physical (mass, dimension, densities etc.) as well as strength characteristics are dependent on absorption of moisture. Catamarans being fabricated using low density timbers, their quality assessment forms an important attribute for adopting a right species for the job. The Scientific finding will be of use to Fishing Community.

Results/Achievements : The absorption rate of moisture from air dry condition to the stages of 10 cycles of repeated wetting and drying was significantly different in treated as well as untreated wood. Though the rate curves showed initial sharp gradient up to 3 cycles, subsequent wetting and drying showed asymptotic behaviour.

Improved dimensional stability and reduced surface degradation was observed in treated timbers.

Progressive increase in cluster size was observed with the increase in relative humidity. Cluster size was higher in undecayed wood blocks at humidities from 15% to 76%. Magnitude of wood decay can be quantified in terms of cluster size of water molecules.

Sl. No. : IWST OC –13

Project identification No.: CFP 001*

Name of the principle investigator : K.S. Theagarajan

Title of the project : Studies on qualitative improvement of *E.* hybrid oil for value addition.

Year of start of the project : April 1998

Cost of the project : Rs. 5.00 lakh

Objectives : To modify *E.* hybrid leaf oil to get pleasant smelling oil of perfumery value.

Scientific importance of investigations: Pleasant smelling *E.* hybrid oil, if made available in large quantities, will be useful in perfumery industry. It will also result in value addition and revenue to State Forest Departments due to better utilization of foliage and its oil.

Results/Achievements: Aroma enhanced/chemically modified oils were obtained from less utilized *Eucalyptus* hybrid oil by $K_2Cr_2O_7$-H_2SO_4 and Alc-PTS reactions. Hydro-distillation of *E.* hybrid leaf with $KMnO_4$ (oxidation) results in enrichment of cineole. The process is being standardized.

Sl. No. : IWST OC – 14

Project identification No.: CFP 002

Name of the principle investigator : K.S. Theagarajan

Title of the project: Phytochemical investigations of *Machilus macrantha.*

Year of start of the project : April 1997

Cost of the project : Rs. 5.22 lakh

Objectives : Bark of *Machilus macrantha* is used as a binder (Jigat) in agarbathi industry. There is acute shortage of bark due to over exploitation. Scientific method of debarking with timely application of pesticides to get maximum bark protecting this valuable tree is the aim. The bark will also be subjected to chemical examination for its industrial utility.

Scientific importance of investigations : The bark extractives obtained by solvent extraction have not been studied so far. The fractions/chemical constituents of bark extractives have to be examined from pharmaceutical point of view.

Results/Achievements: Leaving one or two strips of bark intact along the trunk of the tree and spraying the tree with insecticide/fungicide mixture helped in its survival. Regeneration of bark (Jigat) was found to be satisfactory (90%) with least damage to standing trees.

Sl. No.: IWST OC – 15

Project identification No.: CFP 003

Name of the principle investigator : K.S. Theagarajan

Title of the project : Studies on Red sanders wood.

Year of start of the project: April 1997

Cost of the project : Rs. 5.00 lakh

Objectives: Red sanders (*Pterocarpus santalinus*) wood has great export value mainly on account of its physical and chemical properties. Wavyastraight grained wood occur in nature. It has red colouring matter. Isolation and utility of the colouring matter (santalenes) has to be studied. Physico-chemical differences, if any, between the wavy and straight grained wood has also to be investigated.

Scientific importance of investigations: The study will help understand fundamental difference between way and straight gained wood of this species.

Results/Achievements: Sequential extraction of red sanders powder with Benzene, Ethyl Acetate and Ethanol gave chemically varied extracts which have exhibited specific antimicrobial properties.

Sl. No. IWST OC – 16

Project identification No.: CFP 004

Name of the principle investigator : K.H. Shankaranarayana

Title of the project : Preparation and screening of compounds of biocidal and pharmacological activity - chemical investigations on steam and non-steam volatile components of creosote and testing their biocidal efficacy.

Year of start of the project : April 1997

Cost of the project : Rs. 5.07 lakhs

Objectives: Wood extractives from durable timber or their fractions can serve as biocidal compounds possessing anti-termite, antifungal or antibacterial activity. Bark extract and oil of *E.* hybrid were also found to have weedicidal effect on Parthenium grass. Steam volatile portions of creosote (40%) is also being examined from this point of view.

Scientific importance of investigations : Environmental friendly biocidal compounds from natural sources will be available.

Results/Achievements: Chemical composition of creosote steam volatiles by HPLC has indicated the presence of methyl naphthalene. Further work is in progress.

Sl. No. : IWST OC – 17

Project identification No.: CFP 005

Name of the principle investigator : K.H. Shankaranarayana

Title of the project : Chemical and utilization studies on *Pterocarpus marsupium* wood.

Year of start of the project : April 1997

Cost of the project : Rs. 5.90 lakh

Objectives : Optimum extraction of colouring matter. *In situ* conversion of colouring matter of wood into water insoluble complex to prevent leaching out.

Scientific importance of investigations: The study will help prevent leaching of water soluble colouring matter from this important timber used in construction.

Results/Achievements : Chemical treatments viz., i) $CuSo_4 + K_2Cr_2O_7$, ii) $ZnCl_2 + CuCl_2 + K_2Cr_2O_7$ and CrO_3 are effective in preventing the leaching of water-soluble colouring matter from the wood of *Pterocarpus marsupium*.

Sl. No.: IWST OC – 18

Project identification No.: WBD- ENT- 3

Name of the principle investigator : Dr. O.K. Remadevi

Title of the project: Study of insect pests of nurseries plantations and of natural forests and their control.

Year of start of the project: 1997

Cost of the project: Rs. 7.29 lakhs

Objectives : (a) To identify the pest problems and study the seasonal occurrence and population intensities. (b) To study the biology, host spectrum, natural enemies etc. (c) To evolve suitable prophylactic and other control measures.

Scientific importance of investigations: The knowledge on the seasonal occurrence and population dynamics of the pests shall help in predicting the pest out-breaks and thereby adopting suitable control measures. The information on host spectrum and natural enemies shall help in evolving suitable management practices to keep the population under check.

Results/Achievements: Major pest problems in the forest nurseries, plantations and natural forests of Karnataka were studied. The pest stages were collected, identified and bio-ecological aspects were observed in the laboratory.

The spiralling whitefly, *Aleurodicus dispersus* has been found to breed on many host trees viz; *Cocos nucifera, Terminalia catappa, T.arjuna, Musa* sp; *Cassia siamea, C.spectabilis, C.javanica, Morus* sp., *Mangifera indica, Ficus religiosa, F.retusa, F. elastica, Hibiscus rosachinensis, Eucalyptus tereticornis, Dalbergia latifolia, Punica granatum, Anona squamosa, Carica papaya, Phyllanthus niruri, Santalum album, Acacia mangium, Gossypium* sp., *Cordia myxa* and *Loranthus* sp., in and around Bangalore, in addition to ten important forestry species reported earlier. Among them 11 are new host records. Two species of predators namely *Chrysopa* sp., and *Cryptolaemus montrorizieri* have been found feeding on this whitefly.

The cerambycid beetle, *Batocera rufomaculata* is known to be highly polyphagous affecting more than 33 tree species. *Ceiba pentandra* has been found as a favorable host of this pest.

Sl. No.: IWST OC – 19

Project identification No.: WBD-PATH-1

Name of the principle investigator : H.C. Nagaveni

Title of the project: Natural durability of different timbers and timber products against decay under terrestrial conditions.

Year of start of the project: 1997

Cost of the project: Rs. 6.44 lakhs

Objectives: (a) Evaluation of natural durability of unknown timbers. (b) Testing the decay resistance of wood products made of different species.

Scientific importance of investigations: As primary timbers are fast depleting due to heavy demand of the daily needs, it has become inevitable to use available secondary species. By evaluating durability class, the wood can be utilized properly with or without treatment based on the requirement. This will help in conserving forests.

Results/Achievements: Pure cultures of wood rotting fungi viz., *Fomes annosus* (Fr.) Karst., *Lenzites trabea* (Pers.ex.Fr.) Fr., *Polyporus hirsutus* Wulf. Ex. Fr., *Polyporus meliae* undrew, *Polyporus palustris* Berk. Ex. Curt., *Polyporus sanguineus* L. ex Fr., *Polyporus versicolor* L. ex Fr.; mold and sap stain viz., *Ceratocystis ulmi, Botrydiplodia theobromae, Chaetomium globosum, Trichoderma viride, Sporotrichum pulverulentum, Pencillicum spinolosum* are being maintained in laboratory in virulent condition required for bioassay studies in lab. Some of these pure cultures were also supplied to various Institutes and Universities for their study. Marine wood fungi have been isolated from affected catamarans and are being sub cultured to get pure strain. Effect of these isolated fungus on wood blocks are being tried under laboratory conditions.

Sl. No. : IWST OC – 20

Project identification No.: WBD-PATH-4

Name of the principle investigator : H.C. Nagaveni

Title of the project: Studies on diseases of seedlings in nurseries, plantations and natural forest.

Year of start of the project: 1996

Cost of the project. : Rs.6.43 lakhs

Objectives : (a) Studying of diseases and their seasonal occurrence in forest nurseries and plantations. (b) Protection of forestry seedlings in nurseries and plantations against diseases through adoption of prophylactic and control measures.

Scientific importance of investigations: Out break of diseases is a common feature in forest nurseries and plantations. This project will help mass production of better quality seedling and establishment of well stocked plantations.

Results/Achievements:

***Santalum album* seedlings:** Frequent attack of wilt disease in sandal seedlings and leaf curling was observed. The disease was controlled by minimum watering followed by spraying of Bordeaux mixture.

Acacia mangium: There was severe wilt problem in the species and was controlled by control watering followed by Bordeaux treatment.

A. auriculiformis: Seedlings had severe problem of powdery mildew and whole seedling was covered by white patches of infection. The disease came under control by treatment of seedlings with Sulfex fungicide.

Casuarina equisetifolia: Seedling was covered with black powdery masses of pathogen which was leading to retardation of growth. The reasons was attributed to *Trichosporium vesiculosum* pathogen. Disease was brought under control by spraying Copper fungicide.

***Eucalyptus* hybrid:** Seedling has the problem of leaf spot disease with dark brown spot on leaves and was controlled by using 0.1% Blitox.

Sl. No: IWST OC –21

Project identification No.: WBD- MARINE - 1

Name of the principle investigator : Dr. K.S. Rao

Title of the project: Studies on durability of different timber and timber products against biodeterioration under marine conditions.

Year of start of the project: 1997

Cost of the project : Rs. 12.81 lakhs

Objectives : (a) Long-term observations on the fluctuations in occurrence, distribution and ecology and biology of marine wood-boring and fouling organisms. (b) To assess the natural durability of different species of Indian timbers and various panel products. (c) To assess the efficacy of wood preservatives in enhancing durability of timbers. (d) To study the marine fungi and inter-relationship between microorganisms (preconditioning effect of primary film) and wood-infesting organisms. (e) To study environmental implications of bio-deterioration control measures.

Scientific importance of investigations: The data generated under the activities of this project will be useful for evolving methods to prolong the life of timber under marine conditions. A wider varity of timber would be used.

Results/Achievements: In all, 82 untreated timber species were exposed at Krishnapatnam waters along the East Coast of India. Species like *Xylia xylocarpa, Adina cordifolia* and *Garcinia indica* performed much better and are still under trial even after 18 months of exposure. About 10 species of woodborers are identified from the panels. Barnacles, serpulid and Bryozoans were the main fouling components in this region.

Tests on the natural durability of five hitherto untested species namely, *Achras sapota, Buchanania axillaris, Elaeocarpus recurvatus, Stereospermum chelonoides* and *Wrightia tinctoria* were started during the month of January, 2000 in Visakhapatnam harbour.

Durability tests with nine species of catamaran grade timbers treated with CCA and CCB preservatives showed that panels of *Bombax ceiba* treated with CCA and that of *Erythrina indica* and *Ficus mysorensis* with CCB were continuing in the field suffering meager destruction of 5-10% at the end of 42 months of exposure trials, whereas panels of other species succumbed to borer attack in 33 to 39 months. Test panels of Hem Fir and Southern Pine treated with ACZA, CDDC and CDCC wood preservative were continuing in very sound condition at the end of 12 months of marine exposure trials while their untreated controls were heavily damaged in 6 months. A new proprietary wood preservative called Protecto was obtained from the manufacturers and small test coupons were treated with it for conducting accelerated laboratory tests to find out it's efficacy in preventing marine wood borer attack.

For environmental implication studies, adult teredinids were marked on borer infested test panels and were exposed to different concentrations of copper to study the tolerance and bioaccumulation of the metal by the wood boring teredinids. The extracted specimens have been wet-ashed for further analysis. Studies on oxygen consumption of teredinids under copper stress revealed that oxygen uptake decreased in animals exposed to copper compared to animals maintained in copper free medium.

Sl. No. : IWST OC –22

Project identification No.: WBD- MARINE-2

Name of the principle investigator : Dr. K.S. Rao

Title of the project: Studies on biodeterioration of mangrove and coastal vegetation.

Year of start of the project: 1997

Cost of the project : Rs.16.33 lakhs

Objectives : (a) To study the occurrence, distribution, systematic, ecology and biology of marine borers, foulers and fungi and associated organism in mangroves of Goa, Karnataka and Andhra Pradesh. (b) To study the insect borers and defoliators of coastal zone vegetation. (c) To assess the extent of damage caused by marine wood-infesting organisms to living mangrove vegetation and also host specificity. (d) To suggest ways and means to minimize damage to mangrove vegetation, including seedlings, for effective afforestation and management of this endangered ecosystem.

Scientific importance of investigations: Data generated will be useful in evolving effective control measures and conserving the mangrove and other coastal habitat.

Results/Achievements : Detailed studies on the insects, marine borers, foulers and also of fungi associated with the mangrove and coastal forest ecosystems of Goa, Karnataka and Andhra Pradesh was initiated. Mangroves in Karwar and Goa were surveyed and 12 species of wood borers and few fouler which are already reported were found prevalent in Goa mangroves. Insects belonging to 20 families of 10 orders have been collected from the mangrove trees of west and east coasts. The major defoliator pests were *Pteroma plagiphleps* on *Rhizophora mucronata* and *Hyblea puera* on *Avicennina officinalis*. Many species of seed borers of *Avicennia* sp., were also collected. Incidence of stem borers on both saplings and trees were observed.

Note : Project not yet complete. It will be submitted to next RAG for extension.

OLD PROJECTS CONTINUED DURING 1999-2000

Sl. No. : IWST OC - 1

Project identification No.: IWST 0001 - WPU 001

Name of the principle investigator : Dr. R.V. Rao

Title of the project: Study of anatomical, physical and mechanical properties of plantation grown timber of *Acacia auriculiformis*, *Acacia mangium* and *Tecomella undulata*.

Sub-project (I): Study of anatomical properties of *Acacia mangium*, *A. auriculiformis* and *Tecomella undulata*.

Sub-project (II): Study of physical and mechanical properties of timber.

Sub-project (III): Study of electrical properties of plantation grown timbers.

Sub-project (IV): Study of Non destructive testing method.

Year of start of the project : April 1996

Target year of completion : March 2001

Cost of the project : Rs.18.19 lakhs

Objectives: (a) To study the anatomical structure of wood with special emphasis on identification of timber, assessment of wood quality. (b) To study the physical and mechanical properties of lesser known and plantation grown timber, classification of different end uses.

Scientific importance of investigations: Quantitative anatomical and strength properties vary within and among trees of the species taken up for the study and have a bearing on specific gravity. The data obtained from destructive testing on strength properties can be correlated with NDT data. Anatomical and strength data suggested end uses. Utilisation of plantation grown species to meet various end use requirements of the society.

Results/Achievements: Data on vessel morphology, fibre morphology, tissue proportions and specific gravity, sapwood, heartwood percentage have been obtained for 8 year old trees *Acacia auriculiformis*. The measurement of DC and AC electrical properties of the plantation grown *Tecomella undulata* with different levels of moisture content in two mutually perpendicular directions i.e. along the grain as well as across the grain have been completed. The analysis of data variation of these electrical properties from pith to periphery within tree is currently being investigated.

Studies of the Electric effect (influence of moisture contents on electrical polarization properties) on the plantation grown timber species Eucalyptus, Rubberwood, Teak and Silver oak were completed and the analysis of data is in progress.

Measurement of various physical properties such as specific gravity and shrinkage (radial, tangential, longitudinal and volumetric) from green to oven-dry conditions within and between trees of *Acacia auriculiformis* (8 years old) are currently in progress.

To develop a suitable faster method for non-destructive testing of timber, timber from different species and varying specific gravity is being tested.

Sl. No.: IWST OC-2

Project identification No.: IWST 0002 - WPU 002

Name of the principle investigator : T.R. Hemavathi

Title of the project : Computer assisted wood identification.

Year of start of the project : April 1995

Target year of completion: March 2002

Cost of the project: Rs.25.07 lakhs

Objectives: Following GUESS and CSIROID programme the database is to be created for computer assisted wood identification of Indian timbers. Using anatomical features, local names and botanical names, window based user friendly software got to be developed which can be used for species identification.

Scientific importance of investigations : Wood when used as a raw material, the primary step involved is its identification. During the last 10 years, the division received nearly 500 enquiries for the identification of timber and about 7000 unknown samples were observed and identified. The procedure followed is a traditional one which is time consuming. However, once the data is computerized, any person with basic training can make use of the programme which has applications in Forestry, Wood Science, Paper Technology, Archaeology, Dendrochrology, Forensic Science and Tree Improvement programmes.

The programme can also be made available on payment basis.

Results/Achievements: A demo programme called WIT (Wood Identification Tool) was developed for computer assisted wood identification of Indian timbers using a professional software expert. The programme is

window based, user friendly and has a potential for expansion, simultaneous use of multiple entries. To create the database, codification using card key features has been completed for 107 species belonging to 26 genera and 16 families from Indian Woods Vol. IV based on general features and macroscopic structure.

Sl. No.: IWST OC-3

Project identification No.: IWST 0004 - WPU 004

Name of the principle investigator : Dr. Vimal Kothiyal

Title of the project : Development of software for calculating the properties - CALPRO.

Year of start of the project : April 1995

Target year of completion : April 2001

Cost of the project : Rs. 18.19 lakhs

Objectives: In India nearly 1200 timber species of commercial importance are available but strength properties of about only 400 species have been worked out. This data is available in the form of research articles which are not easily available to the user. A computer software CALPRO is in the process and aims at calculating strength properties data. The in-built database will contain strength properties data reported so far in various journals/research articles on timber grown in India. In the absence of data on a particular timber, software uses strength-specific gravity relationship.

Scientific importance of investigations: The software aims at collecting all these information in the data base and adds routines and sub routines to extract information in the forms of various queries as required by researches and user industry. It will also help in locating the gaps available and focus the research inputs on those particular areas. Development of various correlations will become easier with data available on the computer. The software will be above to calculate suitability indices, classify the timbers for various end uses. When completed it will speed up the work of answering the queries asked by various departments.

Results/Achievements: Literature survey carried out to collect information for adding on to the database, computer programme developed earlier was further improved by adding new features and sub-routines.

Sl. No. : IWST OC-5

Project identification No.: WSP 2

Name of the principle investigator : N.K. Upreti

Title of the project : Modifications in existing design of solar drying kiln to improve energy efficiency.

Year of start of the project : 1997

Target year of completion : 2000

Cost of the project: Rs. 13.8 lakhs

Objectives : (a) To improve the efficiency of green house type solar timber drying kilns through modification in design. (b) To reduce the drying time of timber. (c) To provide cheaper timber drying kiln to small scale rural saw millers. (d) To popularize the environmental friendly alternative source of energy for drying timbers.

Scientific importance of investigations : Design modification for reducing the drying times of timber will help small scale rural saw millers for continuous supply of processed material.

Results/Achievements : Experiments were carried out for evaluation of heat storing capacity and heat radiating rates in blackened concrete- cement bricks, blackened mud bricks of different sizes of the piles. Results indicated that though the heat storing capacity of common mud brick is high, its radiation rate is very fast. In the case of blackened concrete - cement bricks heat radiating rate was slow and heat storing capacity was comparatively higher.

Note : Project not yet complete. It was resubmitted to RAG 1999 for extension.

Sl. No.: IWST OC - 12

Project identification No.: WSP 9

Name of the principle investigator : P. Narayanappa

Title of the project : Studies on flow in woods by gas permeability measurement.

Year of start of the project : 1999

Target year of completion : 2001

Cost of the project: Rs. 15.12 lakh

Objectives: (a) To evaluate the influence of different steaming periods on gas permeability. (b) To study the effect of annual growth rings on permeability. (c) To evaluate the permeability variation in axial, radial and tangential directions and compare those results with different age group of the same species.

Scientific importance of investigations : These results may be used for developing better methods for the seasoning and treatment of work.

Results/Achievements : Project is in progress.

Sl. No : IWST OC-23

Project identification No.: WBD-PATH-2

Name of the principle investigator : H.C. Nagaveni

Title of the project: Control of biodeterioration with the help of water borne preservatives and bioactive substances under terrestrial conditions.

Year of start of the project: 1997

Target Year of completion : 2005

Cost of the project : Rs. 24.43 lakhs

Objectives : Extension of durability of non durable species by using different type of preservative chemicals which are environmental friendly and mammalian non toxic.

Scientific importance of investigations: Wood is biodegradable material and gets easily attacked by bacteria and fungi if it is not properly treated well in time. Some of the traditional preservatives are hazardous to environment and health. Finding out environmental friendly preservatives will help in enhancing the durability of non conventional timbers and reducing environmental pollution.

Results/Achievements: Clean and odourless preservative formulations have been obtained by steam distillation of creosote. Potential use of this Steam Volatile Creosote (SVC) as an effective preservative has been

tried and results are encouraging. Rubber wood was treated with 3 dilutions (1, 2 and 5%) of SVC (Steam Volatile Creosote) and standard creosote and these treated wood were exposed to wood rotting fungi in accelerated lab test as per IS 4873 1968. Treated wood blocks after 16 weeks of exposure showed less than 10% of weight loss and thus can be classified under high resistance class.

Behaviour of wood rotters on water repellent property of treated rubber wood was studied in laboratory conditions. Different decay patterns have been recorded. Water repellency of rubber wood has its limitation in preventing invasion of brown rot fungi which can survive even in very low moisture content. But the treatment has given complete protection against white rot as moisture absorption through capillary action has been prevented due to chemical change in lignin structure.

Efficacy of ready to use formulations of commercial preservatives like Busan 1009 of Telmark was tried against white and brown rotting fungi by using rubber wood. The chemicals have given complete protection to rubber wood against wood rotting fungi in accelerated lab test as per IS 5873, 1968. Treated wood blocks after 16 weeks of exposure showed less than 10% of weight loss and treatment of wood by this chemical and, therefore, can be grouped under resistance class.

Sl. No: IWST OC-24

Project identification No.: WBD-PATH-3

Name of the principle investigator : H.C. Nagaveni

Title of the project: Studies on biofertilizer.

Year of start of the project: 1995

Target year of completion: 2004

Cost of the project : Rs. 28.23 lakhs

Objectives : (a) Survey for the occurrence of different VAM species associated with forest trees. (b) Application of combinations of different VAM and N2 fixing bacteria for improving the growth of plants. (c) Studying the efficacy of different biofertilizers on different tree species.

Scientific importance of investigations: Better survival and establishment of forestry species in degraded soil is the main problem during afforestation. Inoculation of eco-friendly bio-fertilizer helps in raising healthy seedlings in adverse conditions. The survival percentage of seedlings can be increased by biobertilizer application in adverse conditions.

Results/Achievements: Pure strain of VAM fungi and composite spores are being multiplied in nursery by pot culture technique by using maize as nurse seedlings. Experiments are on to observe the effect of biofertilizer on Sandal seedlings in root trainer and polybags and results are encouraging. Efficacy of VAM fungi is being tested on different forestry seedlings for growth and survival percentage. An experiment has been started in root trainers to see the effect of biofertilizer with the combination of Nitrogen fixing bacteria *Azotobactor chrococum* and composite VAM on *Wrightia tinctoria, Bombax ceiba, Acacia auriculiformis, Eucalyptus* and *Bamboo* species. VAM inoculum was supplied to State Forest Department and NGO's (ISCON) for application to nursery seedlings and field trial experiment.

Project No.: IWST EPA1, IWST EPA2 and IWST EPA3 (described under External Aided Projects) are being carried out by the division.

NEW PROJECTS TAKEN UP DURING 1999-2000

Sl. No.: IWST N-1

Project identification No.: IWST 0009- WPU 009

Name of the principle investigator : Dr. R.V. Rao

Title of the project : Wood quality parameters for improving planting stock of *B. arundanacea*, *Pseudooxytenanthera stocksii* and *Dendrocalamus strictus*.

Year of start of the project: April 1999

Target year of completion: March 2001

Cost of the project: Rs. 9.69 lakhs

Objectives: (a) To assess the quality of *Bambusa arundanacea, Dendrocalamus strictus* and *Pseudooxytenanthera stocksii* with respect to anatomical as well as strength parameters. (b) To create the database and recommend for various uses as alternate to wood. (c) To study the variation of properties with respect to age and localities.

Scientific importance of investigations: Locality affects the quality of bamboo which in turn affects the structure and properties. Bamboos are more advantageous as commercial crops and can be obtained in short rotation. Understanding the variation within clump and among clumps will increase value addition and help exploiting the potential of value addition.

Results/Achievements: Data on within a culm variation in specific gravity of *Pseudooxytenanthera stocksii* collected.

Sl. No.: IWST N-2

Project identification No.: IWST 0010- WPU 010

Name of the principle investigator : S.R. Shukla

Title of the project: Production of reconstituted wood veneer lumber (LVL), Parallel Splint Lumber (PSL) from different plantation grown timber species and to study their physical and mechanical properties.

Year of start of the project: April 1999

Target year of completion: March 2002

Cost of the project: Rs. 24.03 lakhs

Objectives: (a) Studies will be carried out to optimize the processing parameters for the manufacturing of glue laminated wood products like Parallel Splint Lumber (PSL), Laminated Veneer Lumber (LVL). (b) To study the influence of the combination of different specific gravity timber species on the preparation of reconstituted wood products (composites) and its effect on physical and mechanical properties, gluing properties as well as their economic analysis. As a result of these studies, the areas for improvement in using different specific gravity timber species on the manufacturing processes will be suggested.

Scientific importance of investigations: Production of wood products like LVL, PSL from plantation grown small girth timbers. Quality of reconstituted wood products like LVL, PSL will be comparable to solid wood. It is to be emphasized that small girth fast grown logs of plantation timbers can be used for LVL, PSL. These laminates are intended to produce a product with improved macroscopic properties as compared to sawn

timber and hence can be used for structural purposes like I-beams and trusses etc., with a variety of shapes and sizes. New reconstituted wood products having high isotropic (along the grain) strength like natural wood for frame work applications in doors, furniture and joinery would be developed.

Results/Achievements: Work is in progress.

Sl. No. IWST-N3

Project identification No.: IWST 0013 - WPU 013

Name of the principle investigator : S.K. Sharma

Title of the project: Relationship of the wood properties of coppice plantation grown *Eucalyptus* species.

Year of start of the project: April 1999

Target year of completion : March 2002

Cost of the project: Rs. 9.84 lakhs

Objectives: (a) To study the quality of the wood of the coppice sprout and compare it with that of the tree which was coppiced or which supplied branches from the rooted cuttings. (b) To make use of second grown or third grown stumps, which are available after first and second felling for various end uses.

Scientific importance of investigations: These studies will have practical utility in plantation forestry for determining the end uses.

Results/Achievements: Coppiced material is being obtained. Literature survey has been made.

Sl. No.: IWST – N4

Project identification No.: IWST 0014 - WPU 014

Name of the principle investigator : S.R. Shukla

Title of the project: Studies of influence of (1) Microfibril angle and (2) Spiral grains in wood on the strength properties of plantation grown timbers (*Eucalyptus* spp.)

Year of start of the project: April 1999

Target year of completion: March 2002

Cost of the project: Rs. 14.98 lakhs

Objectives: To study the influence of microfibril angle and spiral grain on physical and strength properties of wood.

Scientific importance of investigations: Microfibril angle and spiral grain has effect on shrinkage and strength properties of *Eucalyptus* CPTs. Methods for improvement in processing and usage of timber species will be suggested.

Results/Achievements: The technique for measuring the microfibril angle is currently being standardised. Once the method gets standardized, the correlation between the microfibril angle and the strength properties (specific gravity) will be worked out.

Sl. No.: IWST – N5

Project identification No.: IWST 0011 - WPU 011

Name of the principle investigator : P. Kumar

Title of the project: Wood quality parameters for improving planting stock for *Gmelina arborea.*

Year of start of the project: April 1999

Target year of completion: March 2001

Cost of the project: Rs. 9.20 lakhs

Objectives: To assess the wood quality of *Gmelina arborea* with respect to anatomical as well as strength properties, create the data base and recommend its rational utilisation.

Scientific importance of investigations: The project will give a better understanding of various properties of the species and promote its diverse use.

Results/achievements: Efforts are made to procure the wood material. Literature survey has been made.

Sl. No. IWST - N6

Project identification No.: WBD – ENT – 1

Name of the principle investigator : Raja. Muthukrishanan

Title of the project : Investigations on pest problems of wood in packing cases and handicraft industries.

Year of start of the project: 1999

Target year of completion: 2003

Cost of the project : Rs. 12.49 lakhs

Objectives : (a) Identification of insect pests adversely affecting the wood used in packing and handicraft industries. (b) Studies on the bio-ecology, seasonal occurrence, extent of damage and natural enemies of major pests. (c) To study and evolve appropriate prophylactic and other control methods.

Scientific importance of investigations: The knowledge of the different borers attacking different timber shall be very useful in the utilization of right timber for right purpose. Information on the spectra of harmful insects, species of timber prone to their attack and means of protection against them shall help in increasing the service life of the products and thereby the economic status of artisans and timber traders.

Results/Achievements: Surveys were conducted to know the kinds of timber used and the extent of damage inflicted by the attack of insect pests. Rubber and silver oak were mostly preferred for packing case manufacture. When not treated, it is observed that Bostrychid (*Sinoxylon* sp. and *Heterobostrychus* sp.) attack was common on them. Handicraft products made of wood included toys, carvings and wall plates (with patch work, inlays and relief). The raw materials for toys included *Wrightia tinctoria, Adina cordifolia, Eucalyptus* sp., *Acacia arabica* and *Ficus* sp. The raw wood showed the symptoms of platypodid and scolytid attacks. In the finished products, which are not coated with polish/paint the attack of *Lyctus* sp., was observed. Carvings made of heartwood of rosewood, sandalwood, teak and neem do not suffer any insect damage. Inlay and patch work with untreated plywood as base showed the attack of powder-post beetles, especially Lyctidae. Wood species used for these works are *Artocarpus integrifolia, Syzygium cumini,*

Terminalia arjuna, Michelia champaka, Citrus sp., *Diospyros obenum, Pterocarpus latifolia, Terminalia chebula, Eriodendron anfractuosum* and *Pterocarpus marsupium* etc. Further studies are in progress.

Sl. No.: IWST – N7

Project identification No.: WBD-ENT - 2

Name of the principle investigator : Dr. R. Sundaraj

Title of the projects: Studies on termite problems on trees and timber and their resistance.

Year of start of the project: 1999

Target year of completion: 2003

Cost of the project : Rs.15.57 lakhs

Objectives : (a) To study the occurrence, distribution and systematics of termites infesting timber tree species in Karnataka, Andhra Pradesh and Goa. (b) To maintain the culture of timber destroying termite species. (c) To develop laboratory testing facilities for screening indigenous/exotic tree species for their natural resistance against termites. (d) To evaluate the potential of insecticides / termiticides and botanicals against wood destroying termites.

Scientific importance of investigations: The technique developed to evaluate termite resistance of wood will help in selection of right species for afforestation programmes, especially in termite prone areas. The identification of more potent termiticide for the control of termite will provide way for integrated management of termites.

Results/Achievements: The stakes of *Cleistanthus collinus* and *Tecomella undulata* exposed to field conditions in Nallal showed resistance to the attack of termite even after 12 months of exposure. In an experiment, upto 10 months observations have revealed that cashew nut shell oil afforded 100% anti termite protection to rubber wood, when treatment is done by pressure impregnation. The termite infestation was on an average 5% and 35% on dip treated and spray treated rubber stakes respectively. Rubber stakes treated with chlorpyriphos and also CCA and ACA were found protected against termites even after 36 months of treatment.

EXTERNAL AIDED PROJECTS

Sl. No. : IWST EPA – 1

Project identification No.: 01 FREEP

Name of the principle investigator : K.S. Theagarajan

Title of the project : Research on Sandal.

Year of start of the project : September 1994

Target year of completion: December 2000

Cost of the project : Rs.24.95 lakhs

Objectives: (a) To standardise root trainer based nursery techniques for mass production of quality seedlings. (b) Development of protocol for *in vitro* mass production of quality planting stock.

Scientific importance of investigations: Quality seedlings in large number will be available through modern nursery techniques and tissue culture techniques.

Results/Achievements: Standardised root trainer based nursery techniques for mass production of quality seedlings by optimising the conditions of period of sowing, germination media, transferring stage of seedlings in container, potting mixture, sieve size of potting mixture, size and type of containers, supplementary nutrition and stage of host requirement. Studies on Biofertilizer and further screening of best host for root trainers and seedling production is in progress.

In vitro cloning : Standardised physico-chemical conditions for high frequency multiple shoot induction and further multiplication of *in vitro* differentiated shoots from mature and selected clones. Experiments are being conducted on *in vitro* rejuvenation and root induction.

Sl. No.: IWST EPA – 2

Project identification No.: 02 FREEP

Name of the principle investigator : Dr. R.V. Rao & Dr. T.S. Rathore.

Title of the project : Tree Improvement.

Year of start of the project : September 1994

Target year of completion: December 2000

Cost of the project : Rs.14.37 lakhs

Objectives: (a) To establish and evaluate progeny trials. (b) To develop protocol for vegetative propagation of teak. (c) To develop tissue culture protocols for selected genotypes in teak.

Scientific importance of investigations : The project will help mass production of quality seedlings for large scale afforestation/reforestation.

Results/Achievements : Early growth performance tests of SSO cum progeny trial of *Casuarina equisetifolia* and *Tectona grandis* were carried out.

Studies were carried out to optimize ideal size and type of stem cutting, media auxin (IBA, NAA, NOA) and age of cutting for high frequency root induction for vegetative propagation of Teak. Green leafy stem cuttings and lignified greenish stem cuttings were found to be most successful material.

Eucalyptus tereticornis macropropagation technique was perfected. High success rate was achieved by using soft leafy stem cuttings, obtained from the stump sprouts of VMG of Eucalyptus. Within 5 months plantable clonal material can be produced.

High frequency shoot induction was obtained from nodal segment of teak for *in vitro* cloning.

Sl. No. : IWST EPA – 3

Project identification No.: 03 FREEP

Name of the principle investigator : K.V. Lakshmana Murthy & Dr. T.S. Rathore

Title of the project : Planting Stock Improvement Programme.

Year of start of the project : September 1994

Target year of completion : December 2001

Cost of the project : Rs.110.10 lakhs

Objectives : (a) To establish Seed Production Area of Teak, Casuarina and Eucalyptus. (b) To establish Seedling Seed Orchard cum progeny trial and Clonal Seed Orchard of Teak, Sandal, Casuarina and Eucalyptus. (c) To establish Vegetative Multiplication Garden of Teak, Eucalyptus and Bamboo. (d) To establish a Modern Nursery.

Scientific importance of investigations : This work will provide quality seed and clonal planting material to enhance productivity as well as a base for further tree improvement programme of these selected species.

Results/Achievements : Culling operations in the identified plantations for SPA of *Tectona grandis* (48 ha), *Casuarina equisetifolia* (5 ha) and *Eucalyptus tereticornis* (5 ha) was carried out.

The Clonal Seed Orchards of *Tectona grandis* (2 ha), *Casuarina equisetifolia* (4 ha), *Eucalyptus tereticornis* (2 ha) and *Santalum album* (2 ha) were maintained.

In the Seedling Seed Orchard of *Santalum album* (5 ha), the casuality replacement was done and the initial growth performance assessment was done in the *Tectona grandis* and *Casuarina equisetifolia* (4 ha) seedling seed orchards.

Sl. No. : IWST EPA – 4

Project identification No.: WB FREEP- 3

Name of the principle investigator : Dr. K.S. Rao & P.K. Aggarwal.

Title of the project: Utilization of alternative timber for Catamarans.

Year of start of the project: 1994

Target year of completion: 2000

Cost of the project: Rs.22.92 lakhs

Objectives : (a) To increase service life of catamarans through improvement of alternative timbers for catamaran construction. (b) Generating awareness of and popularizing techniques for increasing the service life of catamarans by involving the timber treatment industry, Fisheries Departments, local authorities, Universities, NGO's etc.

Scientific importance of investigation: Enhancement of service life of catamaran through chemical treatment lead to reduction in investments and widening the choice of species for usage. This would aid in conserving dwindling resources of conventional catamaran timbers. Further, wood preservation technology, readily available, does not involve any change in the basic design of the craft - a factor of paramount importance considering the conservative nature of the user community.

Results/Achievements: Conducted studies on seasonal settlement of borers, foulers and their reproductive cycles, depradatory activities and their tolerance levels to wide hydrographical conditions in Krishnapatnam harbour.

Twelve species of wood boring organisms and 30 species of fouling organisms were identified from the treated and untreated panels. Wood preservatives like ACZA, ACQ and ACC treated panels were tested in Krishnapatnam harbour apart from CCA and CCB. Among these CCA and ACZA treated panels had given promising results.

Various species like *Elaeocarpus recurvatus, Populus ciliata, Macaranga peltata, Samanea saman, Ailanthus excelsa, Trema orientalis, Tetrameles nudiflora* and *Ailanthus malabaricum* were identified as potential alternative species for catamaran construction apart from *Bombax ceiba, Albizia falcataria* and *Albizia chinensis.*

A total of 36 catamarans were launched (31 Catamarans - in Visakhapatnam and 5 Catamarans – in Chennai). 24 catamarans were fabricated and 17 catamarans were treated.

3 brochures were published (in 3 regional languages – Telugu, Kannada and Tamil). Pamphlets (in 3 regional languages - Telugu, Kannada and Tamil) on catamarans were also published. 1 brochure on marine biodeterioration published. Demonstration programmes were conducted in 34 villages of A.P & T.N. Linkages were developed with Fishery Dept., Forest Dept., NGO's; 190 references were collected.

EXTENSION

- Establishment of Research linkages with State Forest Development, State Fisheries Department, Universities, NGOs, Public Sector etc.
- To generate awareness among the end users through audio-visual aids and publication of material in regional languages.

Facilities generated and services rendered

- 20 enquiries were attended in the field of identification of wood samples and a total of 421 samples tested.
- 11 enquiries were attended and 25 samples were tested in the field preservation
- 4 enquiries were attended in the field of NWFP.
- 24 enquiries were attended on entomological and pathological aspects.
- 30 enquiries were attended regarding the supply of seed/seedlings of sandal, *Rauwolfia serpentina*, Casuarina and Teak.
- 1 enquiry regarding pamphlet on sandal sap displacement technique, portable distillation unit and catamaran.

Video film:

Sap displacement method to treat green poles and bamboo time spared – 36 man hours.

Transfer of Technology

Training:

- Training of the Naval dock yard official, Mumbai and Visakhapatnam in the field of identification of important timber was conducted from 30-8-99 to 10-9-99.
- Training of the Naval dockyard official, Mumbai and Visakhapatnam in the field of joining of timber was conducted from 6-12-99 to 10-12-99.

Exhibition

- During visit of World Bank FREEP Supervision team from 4.5.99 to 5.5.99.
- During the visit of Hon'ble Union Minister for Environment & Forests on 13.5.99.
- During Vigyan Mela, IIT, New Delhi in February 2000.

During 2nd INBAR Meeting on "Bamboo Preservation Manual" held at IWST, Bangalore from 21-23 February 2000.

- During workshop on "Sustainable Forest Management through Community participation" at IWST, Bangalore from 15-03-2000 to 16-03-2000.

Kisan Mela

A Kisan Mela was organised at IWST, Bangalore on 30-03-2000 in which 30 farmers participated.

Field demonstration

- At Somwarpet, Coorg District. on 28.12.99
- Khanapur (Dharwar), Karnataka on 6.12.99
- Harohalli (Devanahalli), Karnataka on 14.12.99
- Tirupathi, Andhra Pradesh on 23.03.2000

Seminars, Workshops etc.

- Conducted workshop on Second Eco-development Project at IWST, Bangalore on 21-22nd of December 1999.
- Conducted 2nd INBAR meeting on Bamboo Preservation Manual in collaboration with INBAR from 21st to 23rd February 2000.
- Conducted workshop on "Sustainable Forest Management through Community Participation" from 15th to 16th of March 2000.

FINANCIAL STATEMENT FOR THE YEAR 1999-2000

I. PLAN			
Sl.No.	**SUB-HEAD**		**Expenditure (Rs. in lakh)**
1.	**A.**	**REVENUE EXPENDITURE**	
		a. Research	91.96
		b. Administrative Support	62.45
		c. Others specify	-
		Total for Revenue Expenditure 'A'	**154.41**
	B.	**LOAN AND ADVANCES**	
		a. Loan Advances (Conveyance)	2.00
		b. House Building Advance	0.73
		Total for 'B'	**2.73**
	C.	**CAPITAL EXPENDITURE**	
		a. Building & Roads	-
		b. Equipments, Library Books	1.62
		c. Vehicles	-
		d. Other specify	-
		Total for 'C'	**1.62**
		GRAND TOTAL FOR A+B+C(PLAN)	**158.76**
II. NON-PLAN			
	A.	**REVENUE EXPENDITURE**	
		a. Research	52.99
		b. Administrative Support (Salary)	21.99
		Total Non-Plan	**74.98**
		TOTAL FOR PLAN + NON-PLAN	**233.73**
III. FUNDED PROJECT			
		A. World Bank Project	113.41
		B. UNDP Project	2.30
		GRAND TOTAL for (A+B) FUNDED PROJECT	**115.71**